December 1996

National Semiconductor

# LMC272
# CMOS Dual Low Cost Rail to Rail Output Operational Amplifier

## General Description

The LMC272 is a CMOS dual operational amplifier with rail-to-rail output swing and an input common voltage range that extends below the negative supply. Other performance characteristics include low voltage operation, low bias current, excellent channel-to-channel isolation, good bandwidth performance and a competitive price.

These devices are available in MSOP package which is about half the size of a SO-8 device. This enables the designer to fit the device in extremely small applications.

The LMC272C is a direct replacement for TLC272C with performance which meets or exceeds the TLC272C's guaranteed limits in the commercial temperature range when operating from a supply of 2.7V to 15V (see Electrical Characteristics table for details).

These features make this cost effective device ideal for new designs as well as for upgrading existing designs. Applications include hand-held analytic instruments, transducer amplifiers, sample and hold circuits, etc.

## Features

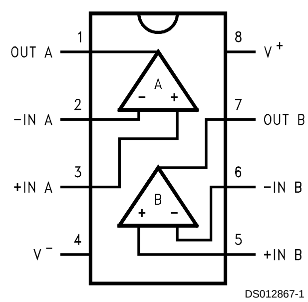
(Typical unless otherwise noted) $V_S$ = 5V, $T_A$ = 25˚C

- Output Swing to within 60 mV of supply rail (10 kΩ load)
- High voltage gain: 90 dB
- Unity gain-bandwidth: 2.0 MHz
- Wide supply voltage: 2.7V to 15V
- Characterized for: 2.7V, 5V, 10V
- Low supply current: 0.975 mA/amplifier
- Input voltage range: −0.3V to 4.2V

## Applications

- Portable instruments
- Upgrade for TLC272C and TS272C
- Photodetector preamplifiers
- D/A converters
- Filters

## Connection Diagram




**Top View**

## Ordering Information

| Package | Ordering Information | NSC Drawing Number | Package Marking | Supplied as |
|---|---|---|---|---|
| 8-pin Molded DIP | LMC272CN | N08E | LMC272CN | Rails |
| 8-pin SO-8 | LMC272CM | M08A | LMC272CM | Rails |
| | LMC272CMX | M08A | LMC272CM | 2.5k Tape and Reel |
| MSOP | LMC272CMM | MUA08A | A07 | Rails |
| | LMC272CMMX | MUA08A | A07 | 3k Tape and Reel |

LMC272 CMOS Dual Low Cost Rail to Rail Output Operational Amplifier

 DS012867

## Absolute Maximum Ratings (Note 1)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.**

| | |
|---|---|
| ESD Tolerance (Note 2) | 2 kV |
| Differential Input Voltage | ±Supply Voltages |
| Voltage at Input/Output Pin | $(V^+)$+0.3V, $(V^-)$−0.3V |
| Supply Voltage ($V^+ - V^-$): | 16V |
| Current at Input Pin (Note 10) | ±5 mA |
| Current at Output Pin (Note 3) (Note 7) | ±30 mA |
| Lead Temperature (soldering, 10 sec.) | 260˚C |
| Storage Temp. Range | −65˚C to +150˚C |
| Junction Temperature (Note 4) | 150˚C |

## Operating Ratings (Note 1)

| | |
|---|---|
| Supply Voltage | $2.5V \le V_S \le 15V$ |
| Junction Temperature Range | |
| LMC272C | $0˚C \le T_J \le +70˚C$ |
| Thermal Resistance ($\theta_{JA}$) | |
| N Package, 8-pin Molded DIP | 115˚ C/W |
| M Package, 8-pin Surface Mount | 177˚ C/W |
| MSOP Package | 235˚ C/W |

## 2.7V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J$ = 25˚C, $V^+$ = 2.7V, $V^-$ = 0V, $V_{CM} = V_O = V^+/2$, $R_L$ to ground, and $R_L$ > 1 MΩ. **Boldface** limits apply at the temperature extremes

| Symbol | Parameter | Conditions | Typ (Note 5) | LMC272C Limit (Note 6) | Units |
|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | $V_O$ = 1.4V, $R_S$ = 50, $V_{CM}$ = 0V, $R_L$ = 10k | 1.40 | 7<br>**9** | mV<br>max |
| $TCV_{OS}$ | Temp. Coefficient of Input Offset Voltage | $T_A$ = 0˚C to 70˚C | **3.9** | | µV/˚C |
| $I_B$ | Input Bias Current | | 1 | **64** | pA<br>max |
| $I_{OS}$ | Input Offset Current | | 0.5 | **32** | pA<br>max |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$ = −0.2V to 1.2V | 77 | 65<br>**60** | dB<br>min |
| PSRR | Power Supply Rejection Ratio | V+ = 2.7V to 5V, $V_O$ = 1.4V | 75 | 65<br>**60** | dB<br>min |
| $V_{CM}$ | Input Common-Mode Voltage Range | CMRR ≥ 50 dB | 1.7 | 1.5<br>**1.2** | V<br>min |
| | | | −0.3 | −0.2<br>**−0.2** | V<br>max |
| $A_V$ | Large Signal Voltage Gain | $V_O$ = 0.25V to 2.45V, $R_L$ = 10k | 88 | | dB |
| $V_O$ | Output Swing | $R_L$ = 10 kΩ, $V_{ID}$ = 100 mV (Note 11) | 2.64 | 2.55 | V<br>min |
| | | $V_{ID}$ = −100 mV (Note 11) | 0 | 20<br>**25** | mV<br>max |
| $I_{SC}$ | Output Short Circuit Current | Sourcing, $V_{ID}$ = 100 mV (Note 11) | 3.7 | | mA |
| | | Sinking, $V_{ID}$ = −100 mV (Note 11) | 2.5 | | mA |
| $I_S$ | Total Supply Current | | 1.60 | 2.5<br>**3.0** | mA<br>max |

## 2.7V AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25^{\circ}C$, $V^+ = 2.7V$, $V^- = 0V$, $V_{CM} = V_O = V^+/2$, $R_L$ to ground and $R_L$ > 1 MΩ. **Boldface** limits apply at the temperature extremes

| Symbol | Parameter | Conditions | Typ (Note 5) | LMC272C Limit (Note 6) | Units |
|---|---|---|---|---|---|
| SR | Slew Rate (Note 8) | $A_V = +1$, $R_L = 10$ kΩ, VI = 1 $V_{PP}$, $C_L = 20$ pF (Note 12) | 1.7 | | V/µs |
| GBW | Unity Gain Frequency | VI = 10 $mV_{PP}$, $C_L = 20$ pF (Note 12) | 1.9 | | MHz |
| $\phi_m$ | Phase Margin | VI = 10 $mV_{PP}$, $C_L = 20$ pF (Note 12) | 39 | | Deg |
| $e_n$ | Input-Referred Voltage Noise | f = 1 kHz, $R_S = 20\Omega$ | 27 | | $\frac{nV}{\sqrt{Hz}}$ |
| $i_n$ | Input-Referred Current Noise | f = 1 kHz | 0.0015 | | $\frac{pA}{\sqrt{Hz}}$ |
| $f_{max}$ | Full Power Bandwidth | $V_S = 10V$, $C_L = 20$ pF, $R_L = 20$ kΩ | 120 | | kHz |
| | Amp-to-Amp Isolation | (Note 9) | 150 | | dB |
| THD | Total Harmonic Distortion | $A_V = +1$, $V_{IN} = 0.7V_{PP}$ f = 1 kHz | 0.035 | | % |

## 5V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J$ = 25˚C, $V^+$ = 5V, $V^-$ = 0V, $V_{CM}$ = $V_O$ = $V^+/2$, $R_L$ to ground and $R_L$ > 1 MΩ. **Boldface** limits apply at the temperature extremes

| Symbol | Parameter | Conditions | Typ (Note 5) | LMC272C Limit (Note 6) | Units |
|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | $V_O$ = 1.4V, $R_S$ = 50, $R_L$ = 10k, $V_{CM}$ = 0V | 1.75 | 7 **9** | mV max |
| $TCV_{OS}$ | Temp. Coefficient of Input Offset Voltage | $T_A$ = 0˚C to 70˚C | **3.3** | | µV/˚C |
| $I_B$ | Input Bias Current | | 1 | **64** | pA max |
| $I_{OS}$ | Input Offset Current | | 0.5 | **32** | pA max |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$ = −0.2V to 3.5V | 77 | 65 **60** | dB min |
| PSRR | Power Supply Rejection Ratio | V+ = 5V to 10V, $V_O$ = 1.4V | 88 | 65 **60** | dB min |
| $V_{CM}$ | Input Common-Mode Voltage Range | CMRR ≥ 50 dB | 4.2 | 4 **3.5** | V min |
| | | | −0.3 | −0.2 **−0.2** | V max |
| $A_V$ | Large Signal Voltage Gain | $V_O$ = 0.25V to 2V, $R_L$ = 10k | 90 | 80 **72** | dB min |
| $V_O$ | Output Swing | $R_L$ = 10 kΩ, $V_{ID}$ = 100 mV (Note 11) | 4.94 | 4.85 **4.75** | V min |
| | | $V_{ID}$ = −100 mV (Note 11) | 0 | 20 **25** | mV max |
| $I_{SC}$ | Output Short Circuit Current | Sourcing, $V_{ID}$ = 100 mV (Note 11) | 16 | | mA |
| | | Sinking, $V_{ID}$ = −100 mV (Note 11) | 16 | | mA |
| $I_S$ | | | 1.95 | 3.2 **3.6** | mA max |

## 5V AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J$ = 25˚C, $V^+$ = 5V, $V^-$ = 0V, $V_{CM}$ = $V_O$ = $V^+/2$, $R_L$ to ground and $R_L$ > 1 MΩ. **Boldface** limits apply at the temperature extremes

| Symbol | Parameter | Conditions | Typ (Note 5) | LMC272C Limit (Note 6) | Units |
|---|---|---|---|---|---|
| SR | Slew Rate (Note 8) | $A_V$ = +1, $R_L$ = 10 kΩ, VI = 1 $V_{PP}$, $C_L$ = 20 pF (Note 12) | 2.5 | | V/µs |
| | | $A_V$ = +1, $R_L$ = 10 kΩ, VI = 2.5 $V_{PP}$, $C_L$ = 20 pF (Note 12) | 2.5 | | |
| GBW | Unity Gain Frequency | VI = 10 mV, $C_L$ = 20 pF (Note 12) | 2.0 | | MHz |
| $\phi_m$ | Phase Margin | VI = 10 mV, $C_L$ = 20 pF (Note 12) | 43 | | Deg |
| $e_n$ | Input-Referred Voltage Noise | f = 1 kHz, $R_S$ = 20Ω | 25 | | $\frac{nV}{\sqrt{Hz}}$ |
| $i_n$ | Input-Referred Current Noise | f = 1 kHz | 0.0015 | | $\frac{pA}{\sqrt{Hz}}$ |
| $f_{max}$ | Full Power Bandwidth | $V_S$ = 10V, $C_L$ = 20 pF, $R_L$ = 20 kΩ | 120 | | kHz |
| | Amp-to-Amp Isolation | (Note 9) | 150 | | dB |
| THD | Total Harmonic Distortion | $A_V$ = +1, $V_{IN}$ = 2.5 $V_{PP}$ f = 1 kHz | 0.015 | | % |

## 10V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J$ = 25˚C, $V^+$ = 10V, $V^-$ = 0V, $V_{CM}$ = $V_O$ = $V^+$/2, $R_L$ to ground and $R_L$ > 1 MΩ. **Boldface** limits apply at the temperature extremes

| Symbol | Parameter | Conditions | Typ (Note 5) | LMC272C Limit (Note 6) | Units |
|---|---|---|---|---|---|
| $V_{OS}$ | Input Offset Voltage | $V_O$ = 1.4V, $R_S$ = 50, $R_L$ = 10k, $V_{CM}$ = 0V | 2.1 | 7<br>**9** | mV<br>max |
| $TCV_{OS}$ | Temp. Coefficient of Input Offset Voltage | $T_A$ = 0˚C to 70˚C | **3.6** | | µV/˚C |
| $I_B$ | Input Bias Current | | 1 | **64** | pA<br>max |
| $I_{OS}$ | Input Offset Current | | 0.5 | **32** | pA<br>max |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$ = −0.2V to 8.5V | 77 | 65<br>**60** | dB<br>min |
| PSRR | Power Supply Rejection Ratio | V+ = 5V to 10V, $V_O$ = 1.4V | 88 | 65<br>**60** | dB<br>min |
| $V_{CM}$ | Input Common-Mode Voltage Range | CMRR ≥ 50 dB | 9.2 | 9<br>**8.5** | V<br>min |
| | | | −0.3 | −0.2<br>**−0.2** | V<br>max |
| $A_V$ | Large Signal Voltage Gain | $V_O$ = 1V to 6V, $R_L$ = 10k | 95 | 85<br>**78** | dB<br>min |
| $V_O$ | Output Swing | $R_L$ = 10 kΩ, $V_{ID}$ = 100 mV (Note 11) | 9.93 | 9.85<br>**9.75** | V<br>min |
| | | $V_{ID}$ = −100 mV (Note 11) | 33 | 45<br>**50** | mV<br>max |
| $I_{SC}$ | Output Short Circuit Current | Sourcing, $V_{ID}$ = 100 mV (Note 11) | 55 | | mA |
| | | Sinking, $V_{ID}$ = −100 mV (Note 11) | 25 | | mA |
| $I_S$ | Total Supply Current | | 2.25 | 3.6<br>**4.0** | mA<br>max |

## 10V AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J$ = 25˚C, $V^+$ = 10V, $V^-$ = 0V, $V_{CM}$ = $V_O$ = $V^+$/2, $R_L$ to ground and $R_L$ > 1 MΩ. **Boldface** limits apply at the temperature extremes

| Symbol | Parameter | Conditions | Typ (Note 5) | LMC272C Limit (Note 6) | Units |
|---|---|---|---|---|---|
| SR | Slew Rate (Note 8) | $A_V$ = +1, $R_L$ = 10 kΩ, VI = 1 $V_{PP}$, $C_L$ = 20 pF (Note 12) | 2.65 | | V/µs |
| | | $A_V$ = +1, $R_L$ = 10 kΩ, VI = 5.5 $V_{PP}$, $C_L$ = 20 pF (Note 12) | 2.65 | | |
| GBW | Unity Gain Frequency | VI = 10 mV, $C_L$ = 20 pF (Note 12) | 2.1 | | MHz |
| $\phi_m$ | Phase Margin | VI = 10 mV, $C_L$ = 20 pF (Note 12) | 44 | | Deg |
| $e_n$ | Input-Referred Voltage Noise | f = 1 kHz, $R_S$ = 20Ω | 25 | | $\frac{nV}{\sqrt{Hz}}$ |
| $i_n$ | Input-Referred Current Noise | f = 1 kHz | 0.0015 | | $\frac{pA}{\sqrt{Hz}}$ |
| $f_{max}$ | Full Power Bandwidth | $C_L$ = 20 pF, $R_L$ = 20 kΩ | 120 | | kHz |
| | Amp-to-Amp Isolation | (Note 9) | 150 | | dB |
| THD | Total Harmonic Distortion | $A_V$ = +1, $V_{IN}$ = 5 $V_{PP}$ f = 1 kHz | 0.005 | | % |

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical characteristics.

**Note 2:** Human body model, 1.5 kΩ in series with 100 pF.

**Note 3:** Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150˚C. Output currents in excess of ±30 mA over long term may adversely affect reliability.

**Note 4:** The maximum power dissipation is a function of $T_{J(max)}$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

**Note 5:** Typical Values represent the most likely parametric norm.

**Note 6:** All limits are guaranteed by testing or statistical analysis.

**Note 7:** Do not short circuit output to V+, when V+ is greater than 13V or reliability will be adversely affected.

**Note 8:** Slew rate is the slower of the rising and falling slew rates.

**Note 9:** Input referred, V+ = 10V and $R_L$ = 100 kΩ connected to 5V. Each amp excited in turn with 1 kHz to produce about 10 $V_{PP}$ output.

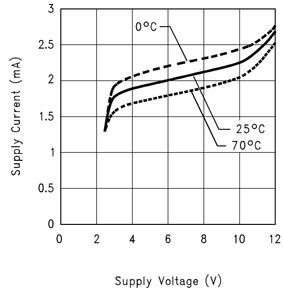
**Note 10:** Limiting input pin current is only necessary for input voltages that exceed absolute maximum input voltage ratings.

**Note 11:** $V_{ID}$ is the differential voltage on the non-inverting input with respect to the inverting input.

**Note 12:** $V_I$ is the input voltage.

## Typical Performance Characteristics ($V_S$ = +5V, single supply, $T_A$ = 25˚C, and $R_L$ to ground unless otherwise specified)

**Supply Current vs Supply Voltage**

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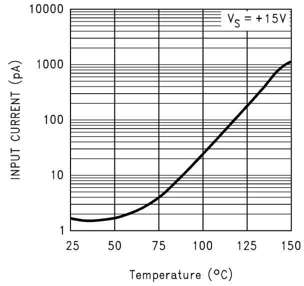
**Input Current vs Temperature**

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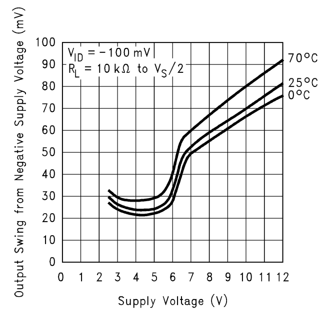
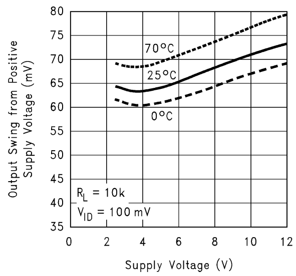
**Negative Output Voltage Swing vs Supply Voltage**



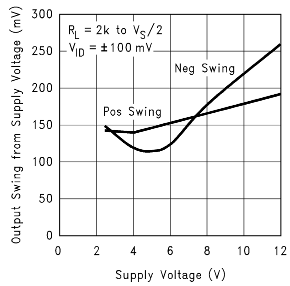

DS012867-7

**Positive Output Voltage Swing vs Supply Voltage**




DS012867-8

**Output Voltage Swing vs Supply Voltage**

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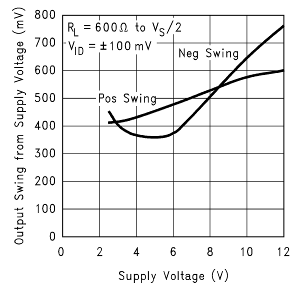
**Output Voltage Swing vs Supply Voltage**

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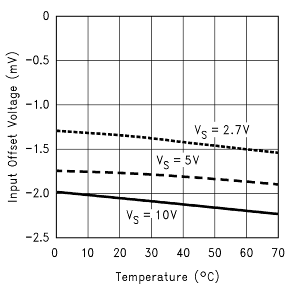
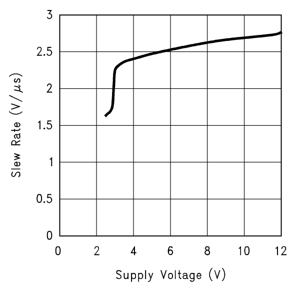
**Input Offset Voltage vs Temperature**



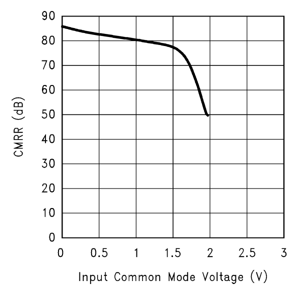

DS012867-11

**Slew Rate vs Supply Voltage**




DS012867-12

**CMRR vs Input Common Mode Voltage ($V_S$ = 2.7V)**

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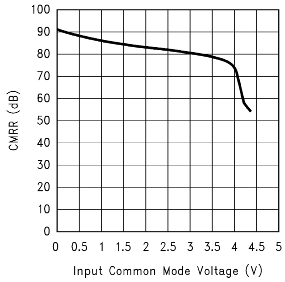
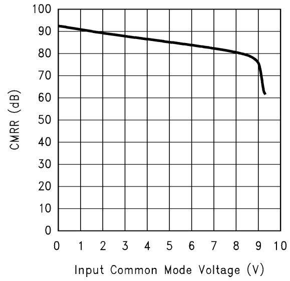
## Typical Performance Characteristics ($V_S$ = +5V, single supply, $T_A$ = 25˚C, and $R_L$ to ground unless otherwise specified) (Continued)

**CMRR vs Input Common Mode Voltage ($V_S$ = 5V)**



DS012867-14

**CMRR vs Input Common Mode Voltage ($V_S$ = 10V)**



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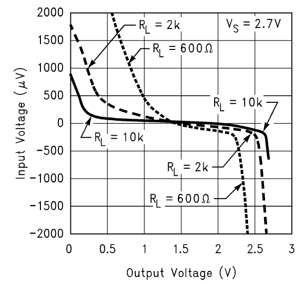
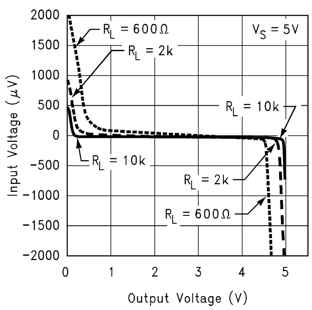
**Input Voltage vs Output Voltage**



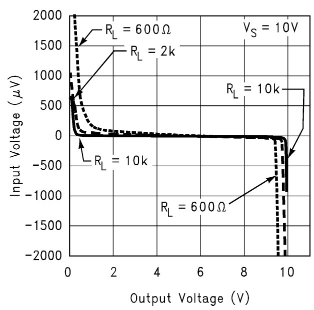
DS012867-16

**Input Voltage vs Output Voltage**



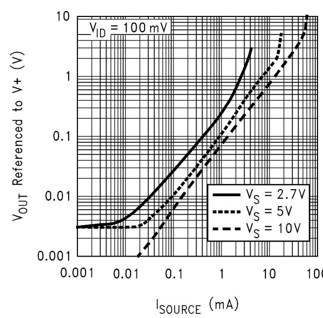
DS012867-17

**Input Voltage vs Output Voltage**



DS012867-18

**Sourcing Current vs Output Voltage**



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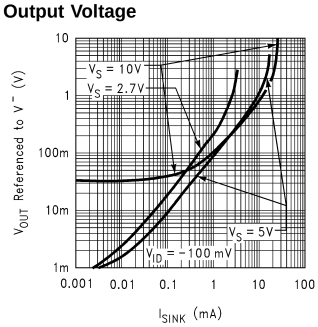
**Sinking Current vs Output Voltage**



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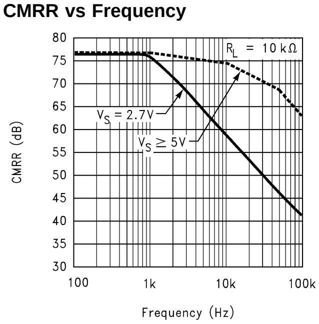
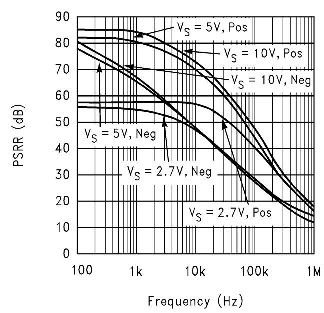
**CMRR vs Frequency**



DS012867-21

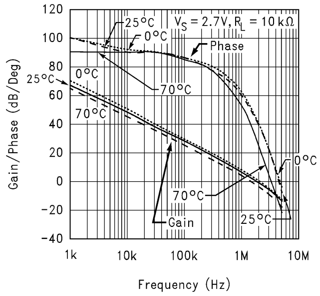
**PSRR vs Frequency**



DS012867-22

## Typical Performance Characteristics ($V_S$ = +5V, single supply, $T_A$ = 25˚C, and $R_L$ to ground unless otherwise specified) (Continued)

**Gain/Phase Response vs Temperature**

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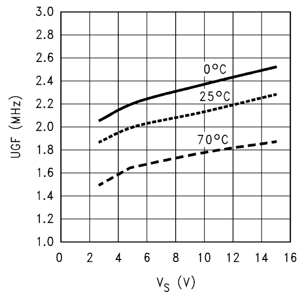
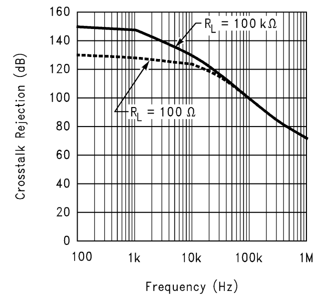
**Unity Gain Frequency vs Temperature**




DS012867-24

**Crosstalk Rejection vs Frequency**

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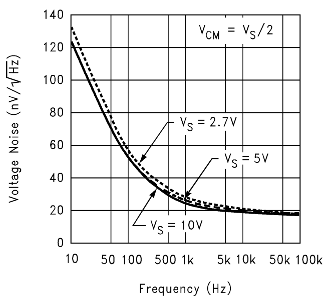
**Input Voltage Noise vs Frequency**

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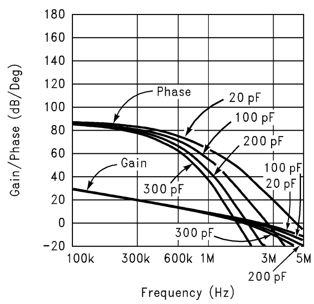
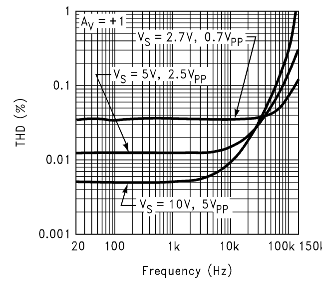
**Gain/Phase vs Capacitive Load**



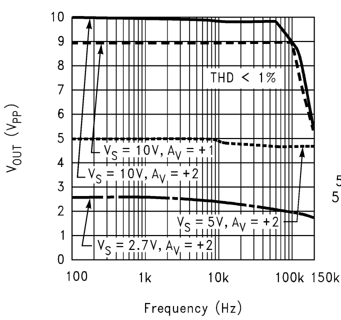

DS012867-27

**THD vs Frequency**



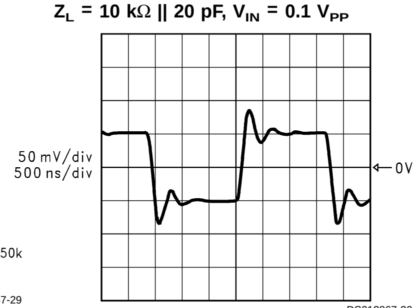

DS012867-28

**Output Swing vs Frequency**




DS012867-29

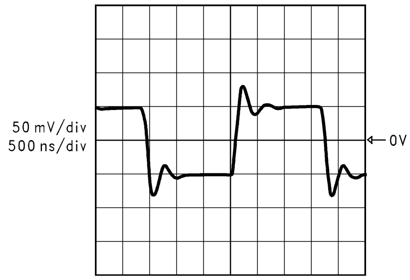
**Small Signal Step Response**
**$V_S$ = ±1.35V, $A_V$ = +1,**
**$Z_L$ = 10 kΩ || 20 pF, $V_{IN}$ = 0.1 $V_{PP}$**




DS012867-30

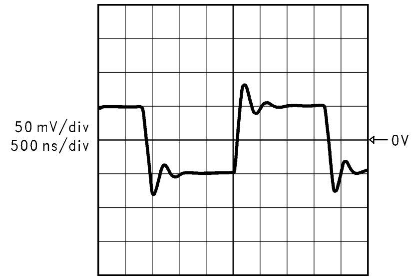
## Typical Performance Characteristics ($V_S$ = +5V, single supply, $T_A$ = 25˚C, and $R_L$ to ground unless otherwise specified) (Continued)

**Small Signal Step Response**
**$V_S$ = ±2.5V, $A_V$ = +1,**
**$Z_L$ = 10 kΩ || 20 pF, $V_{IN}$ = 0.1 $V_{PP}$**



DS012867-31

**Small Signal Step Response**
**$V_S$ = ±5V, $A_V$ = +1,**
**$Z_L$ = 10 kΩ || 20 pF, $V_{IN}$ = 0.1 $V_{PP}$**

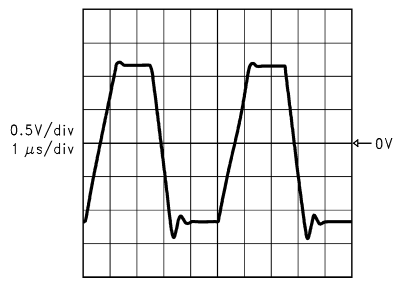


DS012867-32

**Large Signal Step Response**
**$V_S$ = ±1.35V, $A_V$ = +1,**
**$Z_L$ = 10 kΩ || 20 pF, $V_{IN}$ = 1 $V_{PP}$**

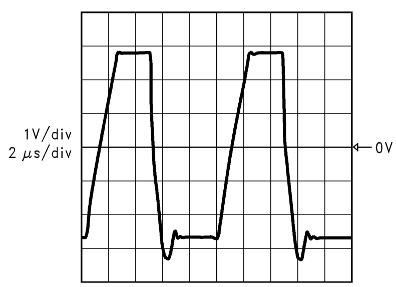
DS012867-33

**Large Signal Step Response**
**$V_S$ = ±2.5V, $A_V$ = +1,**
**$Z_L$ = 10 kΩ || 20 pF, $V_{IN}$ = 2.4 $V_{PP}$**



DS012867-34

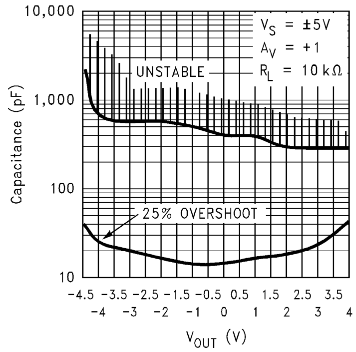
**Large Signal Step Response**
**$V_S$ = ±5V, $A_V$ = +1,**
**$Z_L$ = 10 kΩ || 20 pF, $V_{IN}$ = 5.5 $V_{PP}$**



DS012867-35

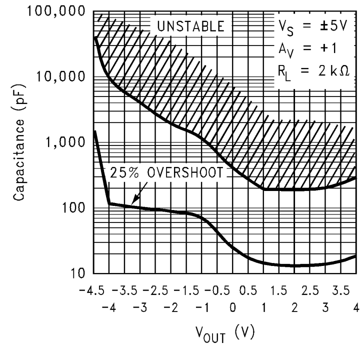
## Typical Performance Characteristics ($V_S$ = +5V, single supply, $T_A$ = 25˚C, and $R_L$ to ground unless otherwise specified) (Continued)

**Stability vs Capacitive Load**




DS012867-36

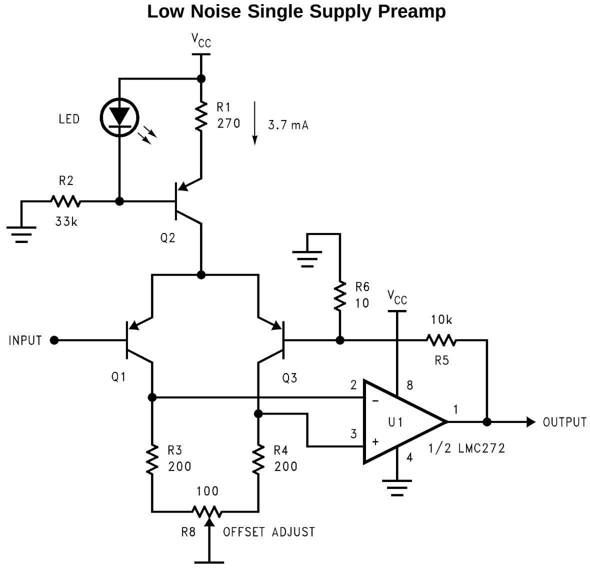
**Stability vs Capacitive Load**




DS012867-37

## Application Information

**Low Noise Single Supply Preamp**




DS012867-2

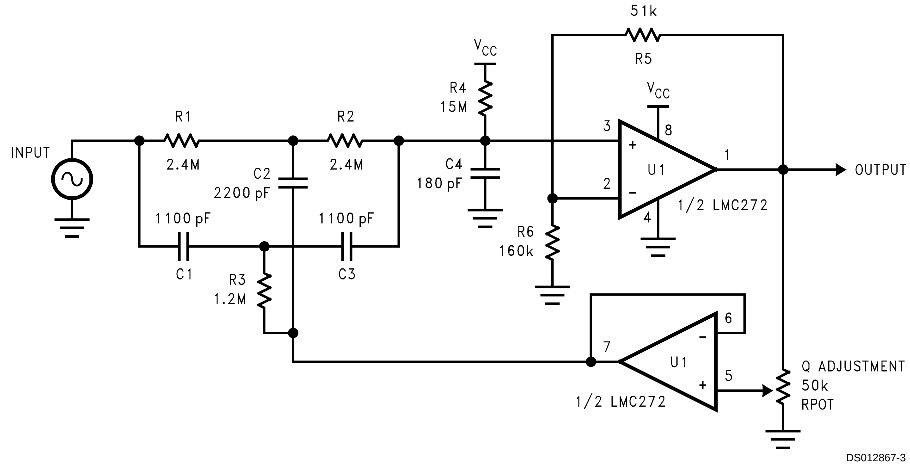
It is generally difficult to find already existing solutions in the market which are single supply and low noise. The circuit above is a low noise single supply preamp using the LMC272. It utilizes the feature of input common mode voltage range to ground to achieve zero-volt-in zero-volt-out performance and uses the RR output swing to achieve maximum dynamic range. By introducing a differential pair operating at high bias current as the front end, the equivalent input noise voltage, $e_n$, is reduced. The gain is 1 + R5/R6 which is a 1000 in this case. There is an inherent trade off between noise voltage and power consumption, input bias current, and input noise current. Input equivalent noise current is inconsequential if the source impedance is small. R1 can be adjusted to vary bias current. To avoid saturation, R3 and R4 should be set such that Q1 and Q3 collector voltages do not exceed 0.5V. *Table 1* shows typical noise data for two different R1 settings:

## Application Information (Continued)

**TABLE 1. Equivalent Input Noise Voltage, $e_n$, for Two Different Values of R1**

| Ω | mA | nV/√Hz | | |
|---|---|---|---|---|
| **R1** | **$I_C$(Q1, 3)** | **$e_n$ (100 Hz)** | **$e_n$ (1 kHz)** | **$e_n$ (10 kHz)** |
| 270 | 1.85 | 3.2 | 2.0 | 1.7 |
| 1000 | 0.50 | 5.3 | 2.4 | 1.9 |

**Single Supply Twin-T Notch Filter with "Q" Adjustment**




Here is another application for the LMC272. This is a single supply notch filter set for 60 Hz using the component values shown, but the frequency can be changed using the equations below. The main feature of this circuit is its ability to adjust the filter selectivity (Q) using RPOT. You can trade off notch depth for Q. *Table 2* shows data for two different settings. The LMC272 lends itself nicely to general purpose applications like this because it is very well behaved and easy to use. This filter can operate from 2.7V to 15V supplies. Component value matching is important to achieve good results. Here R4 is used to set the input to within the common mode range of the device to allow maximum swing on the non-inverting input (pin 3). Since R1, R2, and R4 form a voltage divider at low frequencies, C4 is added to introduce a high frequency attenuation in conjunction with C1, and C3. R5 and R6 were picked to set the pass band gain to 0 dB.

$R = R1 = R2 = 2R3$

$C = C1 = C3 = C2/2$

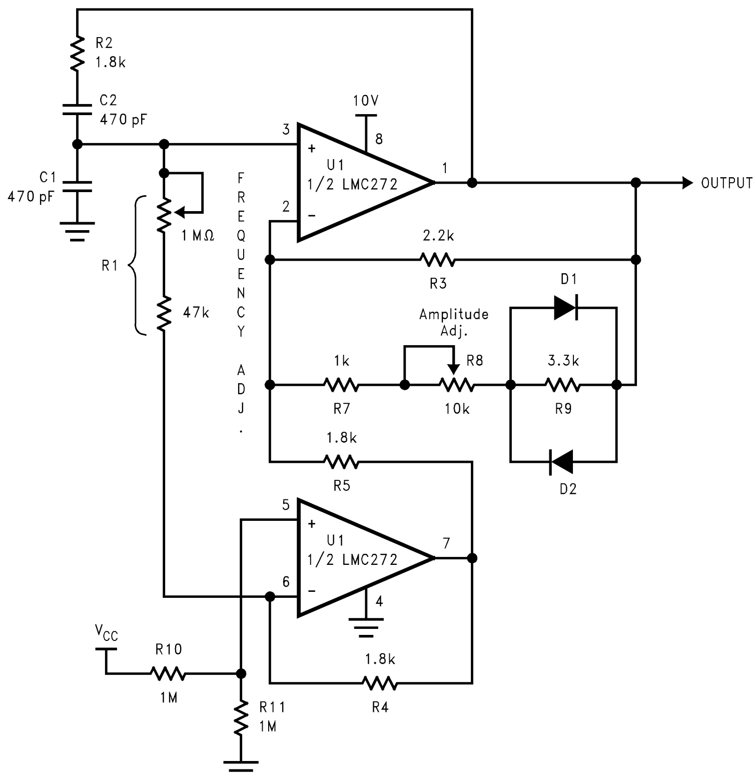
$$f(\text{notch}) = \frac{1}{2\pi RC};\ C4 = \frac{R \bullet C}{R4},\ Q = \frac{f(\text{notch})}{BW}$$

**TABLE 2. Filter Selectivity (Q) vs Notch Depth**

| | (dB) |
|---|---|
| **Q** | **Notch Depth** |
| 0.3 | 40 |
| 6 | 17 |

## Application Information (Continued)

**Single Supply Wein_Bridge Oscillator with Amplitude and Frequency Adjustment**



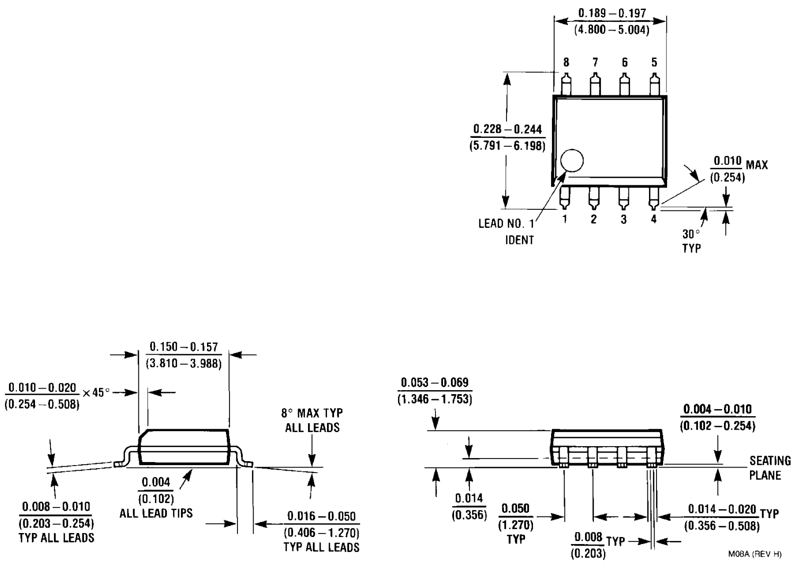

DS012867-4

$$f_{OSC} \cong \frac{1}{2\pi\sqrt{C1\ C2\ R1\ R2}}$$

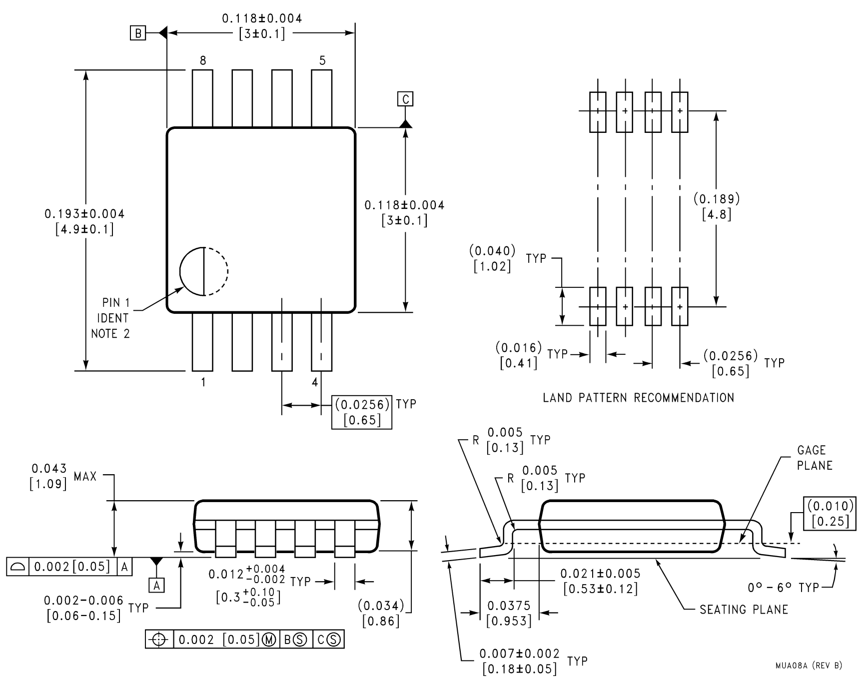
f(range) = 6.4 kHz to 30 kHz

Amplitude Adjustment (range) = 2.8 $V_{PP}$ to 8.6 $V_{PP}$

## Physical Dimensions inches (millimeters) unless otherwise noted

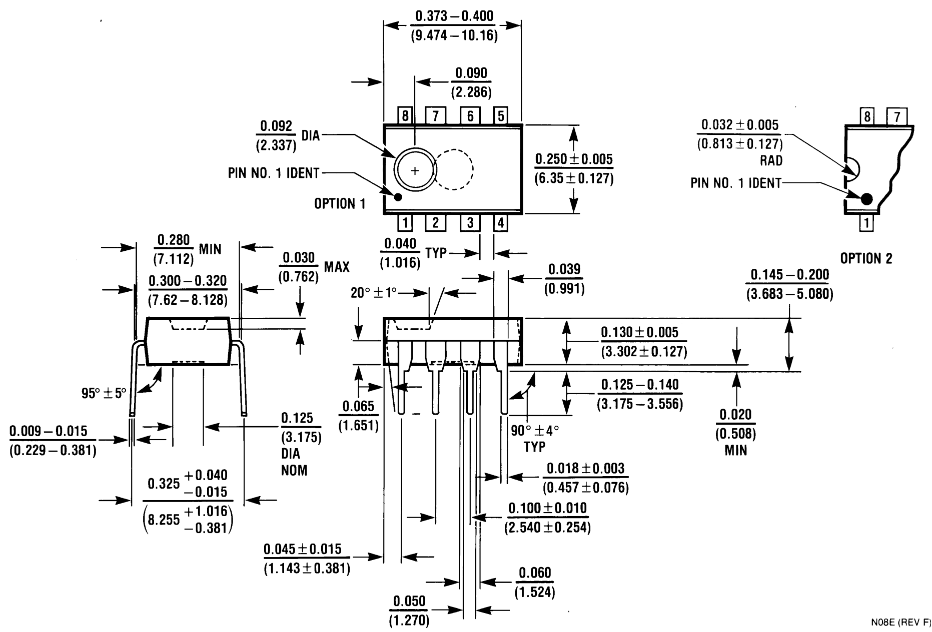



**8-Lead (0.150" Wide) Molded Small Outline Package, JEDEC**
**Order Number LMC272CM or LMC272CMX**
**NS Package Number M08A**




**8-Lead (0.118" Wide) Molded Mini Small Outline Package**
**Order Number LMC272CMM or LMC272CMMX**
**NS Package Number MUA08A**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




**8-Lead (0.300" Wide) Molded Dual-In-Line Package**
**Order Number LMC272CN**
**NS Package Number N08E**

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